CVP-2005-00005
Rev. 0

Cleanup Verification Package for the 600-47 Waste Site

Prepared for the U.S. Department of Energy by Bechtel Hanford, Inc.

August 2005

EXECUTIVE SUMMARY

This cleanup verification package documents completion of interim remedial action for the 600-47 waste site. The 600-47 site is located in the 300-FF-2 Operable Unit in the 300 Area of the Hanford Site in southeastern Washington State. The site consisted of several areas of surface debris and contamination near the banks of the Columbia River across from Johnson Island. Most of the debris and contamination was identified during installation of the 300 Area Treated Effluent Disposal Facility outfall pipeline in 1992 and from area radiological surveys performed in 1993. Debris found at the site included wood, concrete, bricks, glass, steel, plastic, paper, wire, piping, broken bottles, and clay pipe. Contaminated material identified in field surveys included four areas of soil, wood, nuts, bolts, and other metal debris. The four areas of contaminated soil and debris were covered with approximately 0.6 to 0.9 m (2 to 3 ft) of soil for surface stabilization.

Site excavation and waste disposal are complete, and the exposed surfaces have been sampled and analyzed to verify attainment of the remedial action goals. Results of the sampling, laboratory analyses, and data evaluations for the 600-47 site indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met (see Table ES-1).

The site meets cleanup standards for unrestricted land use and has been reclassified as "interim closed out" in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998). A copy of the waste site reclassification form is included as Attachment ES-1.

Table ES-1. Summary of Cleanup Verification Results for the 600-47 Waste Site.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain 15 mrem/yr dose rate above background over 1,000 years.	The cleanup verification statistical value for total uranium above background is 0.472 pCi/g, which is significantly below the unrestricted direct exposure RAG of 56 pCi/g, the concentration corresponding to a 15 mrem/yr excess dose rate (DOE-RL 2004b). No other radionuclide COCs were identified for the 600-47 site.	Yes[a]
Direct Exposure – Nonradionuclides	Attain individual COC RAGs.	All individual COC concentrations are below the RAGs.	Yes[a]
Meet Nonradionuclide Risk Requirements	Hazard quotient of <1 for noncarcinogens.	Hazard quotients were not calculated because all nonradionuclide COCs (arsenic, barium, beryllium, cadmium, chromium, and lead) were detected below statistical background levels.	Yes[a]
	Cumulative hazard quotient of <1 for noncarcinogens.		
	Excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	Excess cancer risks were not calculated because all nonradionuclide carcinogenic COCs (arsenic, beryllium, and cadmium) were detected below statistical background levels.	
	Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.		
Groundwater/River Protection – Radionuclides	Attain single-COC groundwater and river protection RAGs.	All single-COC groundwater and river RAGs have been attained.	Yes[a]
	Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	No beta/gamma-emitting COCs were identified for this site.	
	Meet drinking water standards for nonuranium alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.	Total uranium is the only alpha-emitting COC for this site.	
	Meet total uranium standard of 21.2 pCi/L.[b]	Total uranium statistical values are below cleanup levels for this site.	
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	All the groundwater and river RAGs have been attained.	Yes[a]
Other Supporting Information	Cleanup verification 95% UCL calculation (Appendix C).[a]		
	Cleanup verification sample location design (Appendix C).[c]		

[a] *600-47 Cleanup Verification 95% UCL Calculation*, 0600X-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[b] Based on the isotopic distribution of uranium in the Hanford Site background, the 30 μg/L maximum contaminant level corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).
[c] *600-47 Dump Sites Shallow Zone Sampling Plan*, 0300X-CA-V0055, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
COC = contaminant of concern
MCL = maximum contaminant level
RAG = remedial action goal
UCL = upper confidence limit

Attachment ES-1
Waste Site Reclassification Form

Date Submitted: 08/24/05 **Originator:** R. A. Carlson **Phone:** 373-9759	**Operable Unit(s):** 300-FF-2 **Waste Site ID:** 600-47 Dumping Area **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2005-027 **Lead Agency:** EPA

This form documents agreement among the parties listed below authorizing classification of the subject unit as rejected, closed out, or no action and authorizing backfill of the site, if appropriate. Final removal from the National Priorities List of no action or closed-out sites will occur at a future date.

Description of current waste site condition:

Remedial action at this site has been performed in accordance with remedial action objectives and goals established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. The selected remedial action involves (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to adjacent grade elevations. The excavation and disposal activities have been completed.

Basis for reclassification:

The 600-47 waste site has been remediated to meet the cleanup standards specified in the *Record of Decision for the 300-FF-2 Operable Unit,* as modified by the *Explanation of Significant Differences for the 300-FF-2 Operable Unit Interim Record of Decision* (U.S. Environmental Protection Agency, Region 10, Seattle, Washington). Remedial actions were performed to support unrestricted land use of the shallow zone (i.e., surface to 4.6 m [15 ft] deep) and to protect groundwater and the Columbia River. This site has no deep zone. Therefore, no deep zone institutional controls are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 600-47 Waste Site* (CVP-2005-00005), Bechtel Hanford, Inc., Richland, Washington.

D. C. Smith DOE-RL Project Manager	Signature	8/25/05 Date
NA Ecology Project Manager	Signature	Date
A. Boyd EPA Project Manager	Alicia Boyd Signature	8/25/05 Date

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ACRONYMS AND ABBREVIATIONS

COC	contaminant of concern
DQA	data quality assessment
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant differences
RAG	remedial action goal
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RESRAD	RESidual RADioactivity (dose assessment model)
ROD	Record of Decision
SAP	sampling and analysis plan
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

This cleanup verification package documents that the 600-47 waste site was remediated in accordance with the *Record of Decision for the 300-FF-2 Operable Unit* (ROD) (EPA 2001), as modified by the *Explanation of Significant Differences for the 300-FF-2 Operable Unit Interim Record of Decision* (ESD) (EPA 2004). Remedial action objectives and goals established for the 600-47 site in the ROD (EPA 2001) and ESD (EPA 2004) are reflected in the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (RDR/RAWP) (DOE-RL 2004b). The ROD provides the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial action.

The remedy specified in the ROD and conducted for the 600-47 site included (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility (ERDF) in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to average adjacent grade elevation. Cleanup objectives for the 600-47 site were based on the 300 Area unrestricted land-use scenario established by the ESD (EPA 2004). Excavation was driven by remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, Table 1 presents a summary of the remedial action goals (RAGs) for the radionuclide and nonradionuclide contaminants of concern (COCs) to support unrestricted land use. Preliminary waste site COCs were identified in the *300 Area Sampling and Analysis Plan* (300 Area SAP) (DOE-RL 2004a). Following excavation of the site, final COCs were identified in the *Closeout Plan for Waste Site 600-47* (BHI 2005) and are listed in Table 1.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

The 600-47 site is located in the 300-FF-2 Operable Unit of the 300 Area near the banks of the Columbia River across from Johnson Island (Figure 1). It consisted of surface and subsurface debris including wood, concrete, bricks, glass, steel, plastic, paper, wire, piping, broken bottles, and clay pipe. Contaminated material identified in field surveys included four areas of soil, wood, nuts and bolts, and other metal debris. The four areas of contaminated soil and debris were covered with 0.6 to 0.9 m (2 to 3 ft) of overburden material for surface stabilization. Most of the debris and contamination was identified during installation of the 300 Area Treated Effluent Disposal Facility outfall pipeline in 1992 and from area radiological surveys performed in 1993.

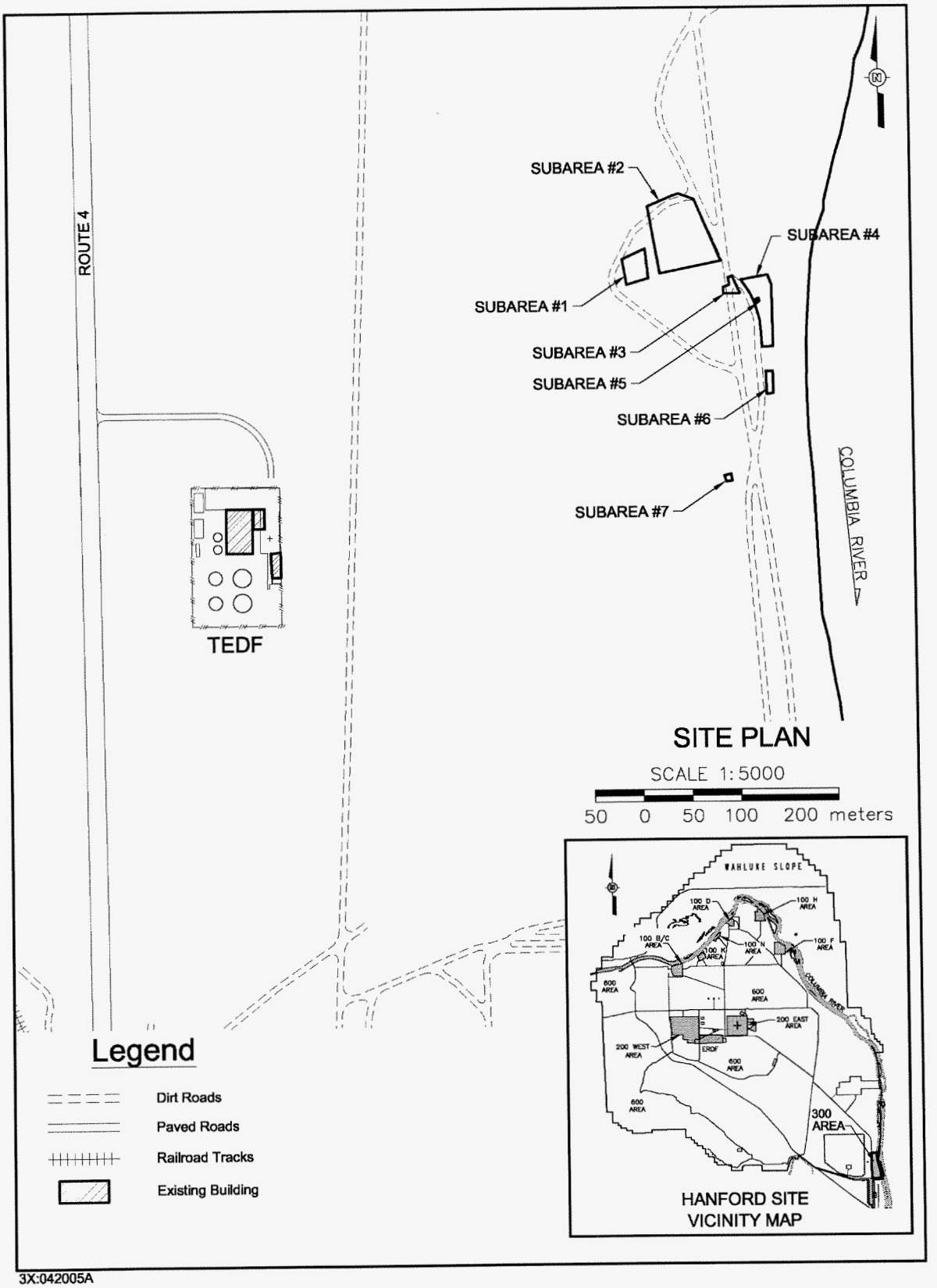
The area within and around the 600-47 waste site is considered culturally sensitive based on proximity to the river, historical location of the pre-Hanford Fruitvale community, and discovery of an archaeological site in 1993 during the Treated Effluent Disposal Facility outfall installation. Some of the debris at the site may pre-date Hanford Site operations.

Table 1. Summary of Remedial Action Goals - Unrestricted Land Use.

COCs	Direct Exposure RAG	Groundwater Protection RAG (pCi/g)	Columbia River Protection RAG (pCi/g)
Radionuclides			
Uranium (total)	15 mrem/yr (cumulative)[a]	37[b]	74
Nonradionuclides			
COCs	**Direct Exposure RAGs (mg/kg)**	**Soil RAG for Groundwater Protection (mg/kg)**	**Soil RAG for Columbia River Protection (mg/kg)**
Arsenic	20[c]	NA[f]	NA[f]
Barium	1,600	NA[f]	NA[f]
Beryllium	10.4[d]	NA[f]	NA[f]
Cadmium	13.9[d]	NA[f]	NA[f]
Chromium	120,000[e]	NA[f]	NA[f]
Lead	353	NA[f]	NA[f]

[a] Lookup values that correspond to the 15 mrem/yr dose rate are based on a generic site model and are presented in the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE-RL 2004b).
[b] Value calculated using RESRAD, based on the generic site model, with a length parallel to groundwater of 100 m, and distribution coefficient values of 8.9 mL/g for the contaminated zone and 0 mL/g for the saturated zone (Figure 3 of the *Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision* [EPA 2004]). The irrigation component of the exposure scenario is the primary reason why this value is lower than the groundwater protection value identified in Table 3 of the *Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision* (EPA 2004). The soil concentrations in both tables are protective of the groundwater at the maximum contaminant level, given the generic site profile and the exposure scenario assumptions.
[c] Value derived from WAC 173-340-750 Method A.
[d] Value calculated based on the inhalation exposure pathway per WAC 173-340-750(4)(b)(ii)(A) or (B).
[e] Measured as total chromium.
[f] Based on the generic site model (DOE-RL 2004b), contaminant will not impact groundwater within the 1,000-year assessment period.
COC = contaminant of concern
NA = not applicable
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Figure 1. Hanford Site Map and 600-47 Site Plan.



3.0 REMEDIAL ACTION FIELD ACTIVITIES

3.1 EXCAVATION AND DISPOSAL

Remedial action activities at the 600-47 site began in December 2004. For the remedial action effort, the site was divided into seven subareas based on observed occurrences of contamination (Figure 1). Material in the radiologically posted and surface stabilized subareas (1, 3, 5, and 7) was sorted as it was excavated and stockpiled within the area of contamination pending sampling and subsequent disposal. Excavated material consisted of contaminated soil and small quantities of metal shavings and miscellaneous construction-type debris. No land disposal restriction materials (e.g., lead solids), anomalies, or liquid wastes were identified in the bulk soil and debris during the excavation process. In addition to the remedial action activities performed in radiologically posted areas, visible surface debris was hand removed from the unposted, nonstabilized subareas (2, 4, 6).

Remedial action excavation was completed in February 2005. Approximately 2,159 metric tons (2,380 U.S. tons) of material from the site were removed and disposed of at ERDF. Pre- and post-remediation topographic maps are shown in Figures 2 and 3. Subareas 2, 4, and 6 are not shown in Figure 3 because no excavation occurred at these locations.

3.2 FIELD SCREENING AND BIASED SAMPLING

Radiological field screening surveys of the excavated areas were performed in February 2005 following remedial action activities. The survey methodology was based on an assumption of uranium as the primary radiological contaminant. Results of the surveys are depicted on a maps based on various ranges of detected uranium activity (Figures 4, 5, and 6). Because the unrestricted cleanup level for uranium is near the sensitivity limits of the survey instrumentation, <50 pCi/g is the lowest range uranium activity depicted on the maps and an increased potential for false-positives exists. All locations where survey results indicated uranium activities >50 pCi/g were investigated further in the field by radiological control technicians (RCTs) assigned to the project. Contaminated items identified by the RCTs during the field investigation were hand removed for disposal at the ERDF. Results from the radiological surveys provided an initial indication that residual soil concentrations of uranium were statistically below the applicable cleanup criteria.

Subsequent to remedial action, biased samples are typically collected at locations where large quantities of specific waste streams were uncovered from a common area to help verify the presence/absence of hot spots in underlying soil. Quantities of waste in the 600-47 site were relatively small, and debris was generally scattered throughout the excavation rather than in any discrete area. In addition, no containerized liquid was found, and no evidence of historical liquid disposal was identified during excavation. Consequently, biased samples were not collected as established in the closeout plan

Figure 2. Pre-Remediation Topographic Plan for the 600-47 Site.

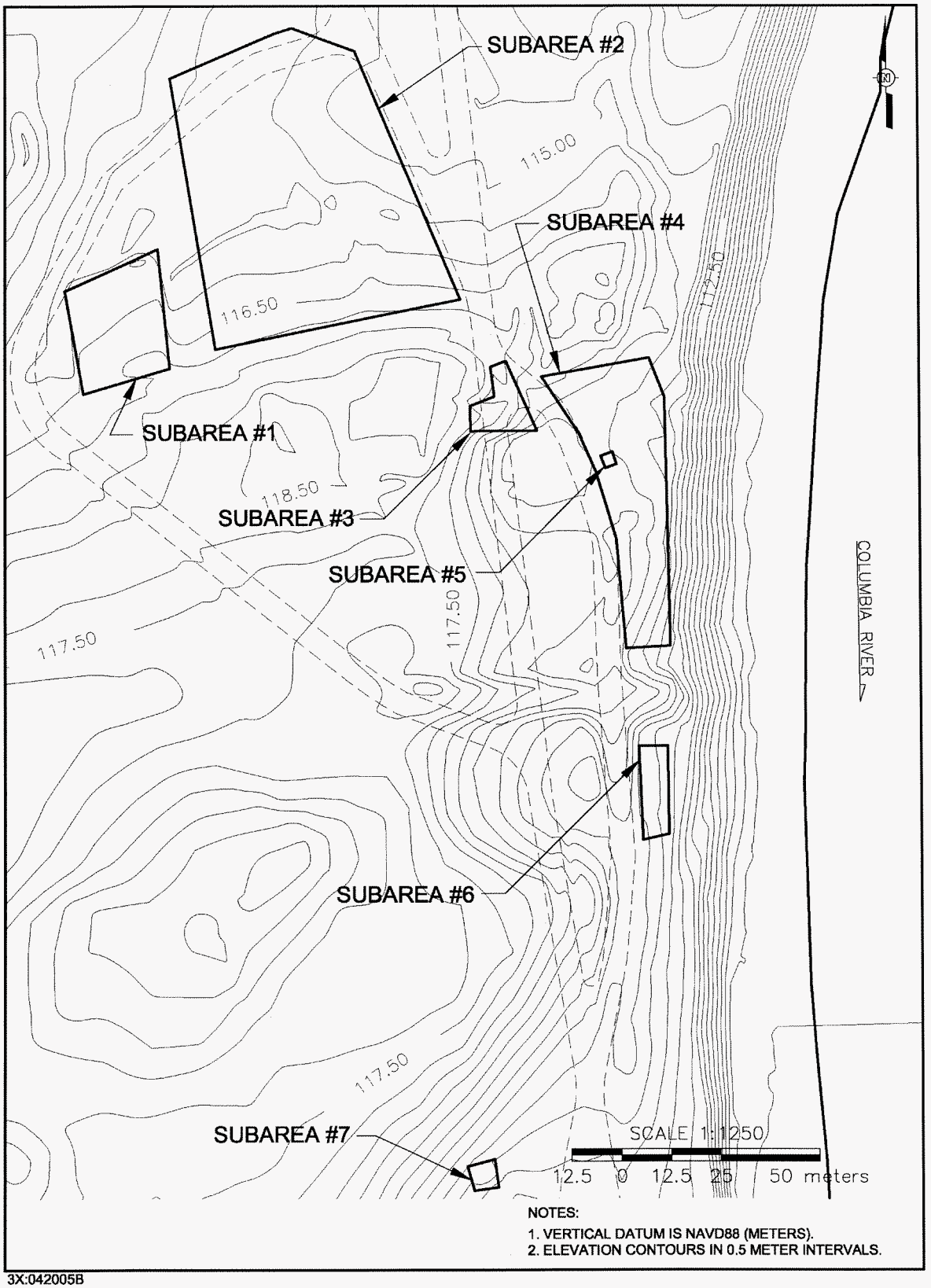


Figure 3. Post-Remediation Topographic Plan for Excavated Areas of the 600-47 Site.

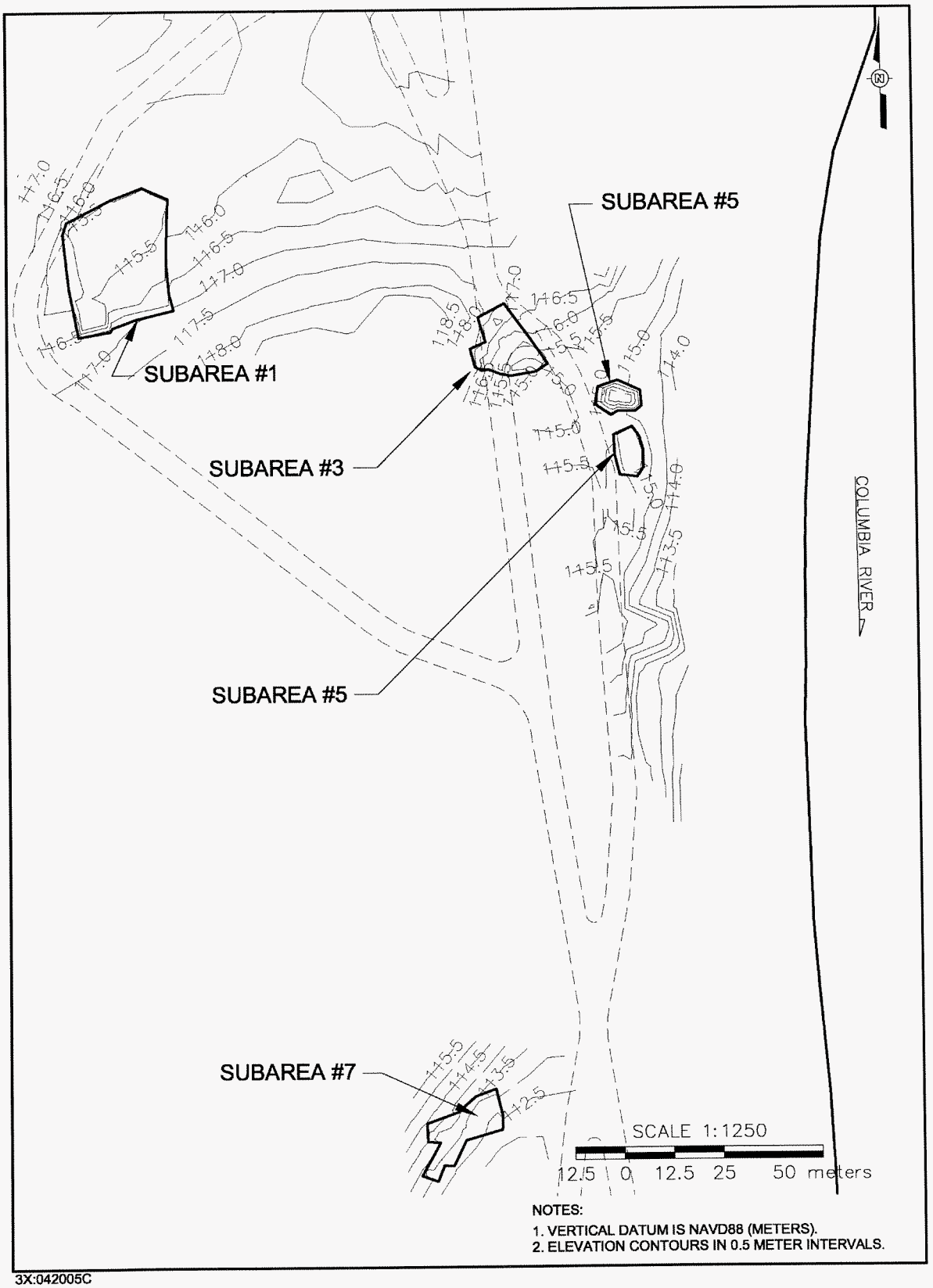


Figure 4. Radiological Mapping Survey Results for the 600-47 Site (Subarea 1).

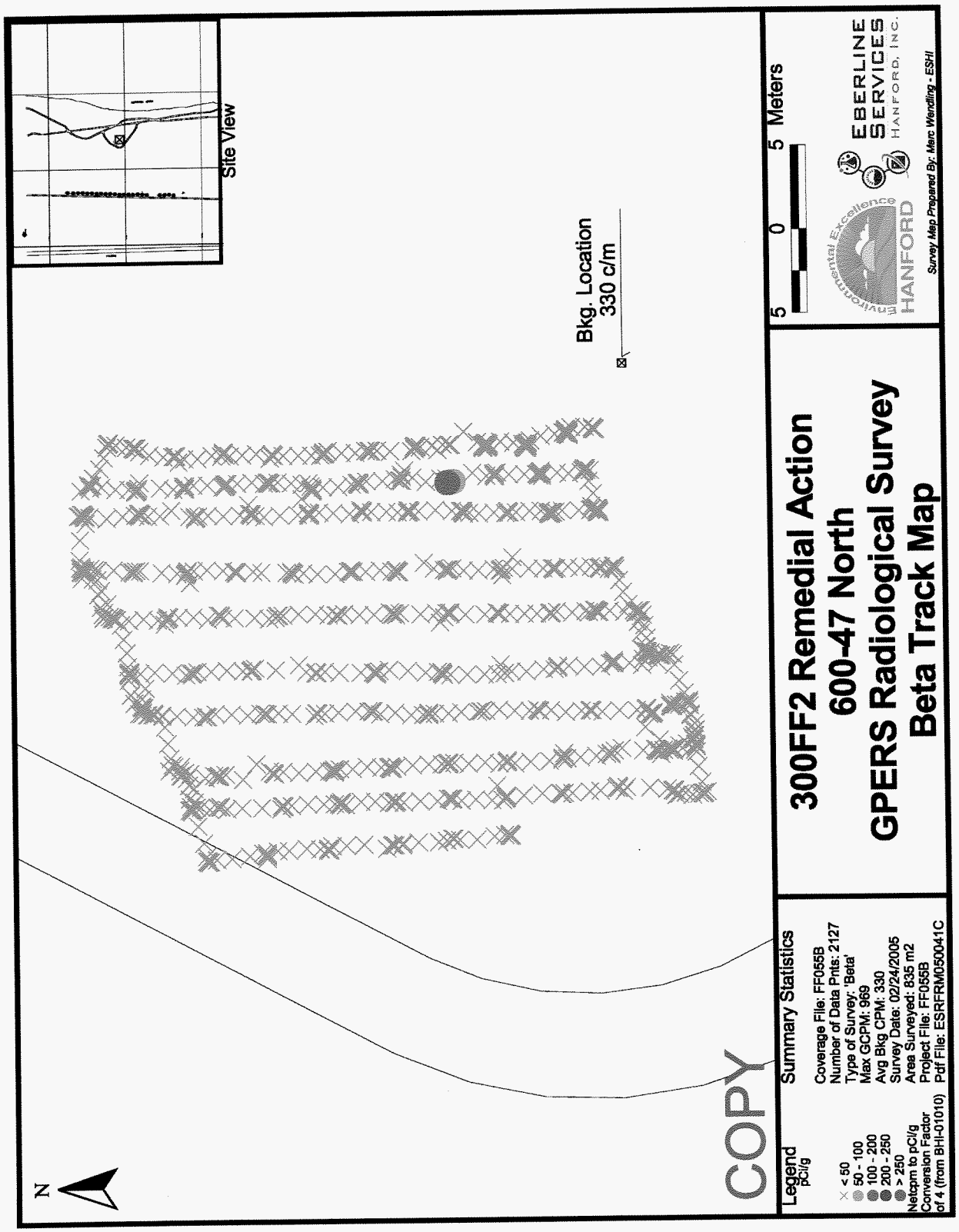


Figure 5. Radiological Mapping Survey Results for the 600-47 Site (Subareas 3 and 5).

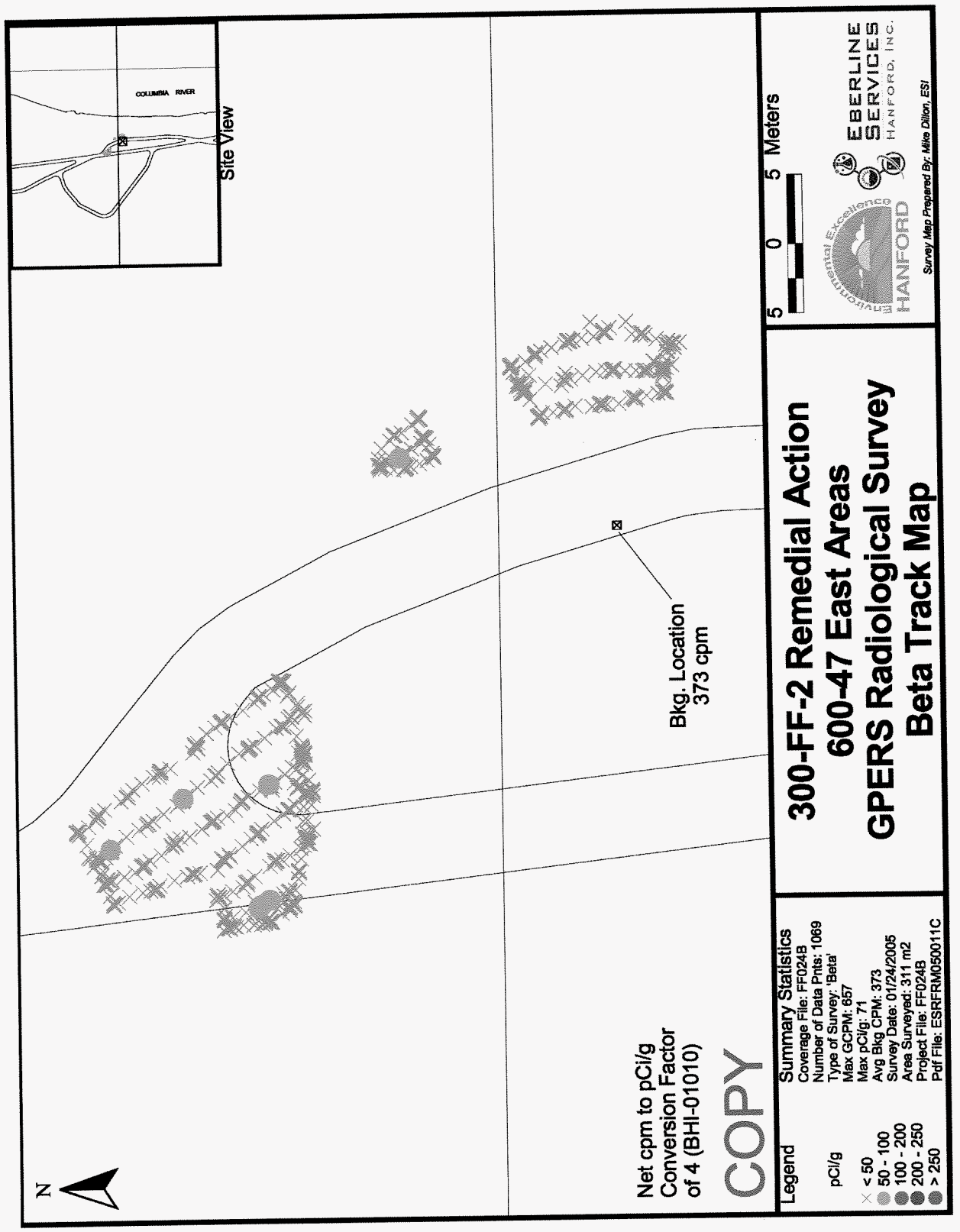
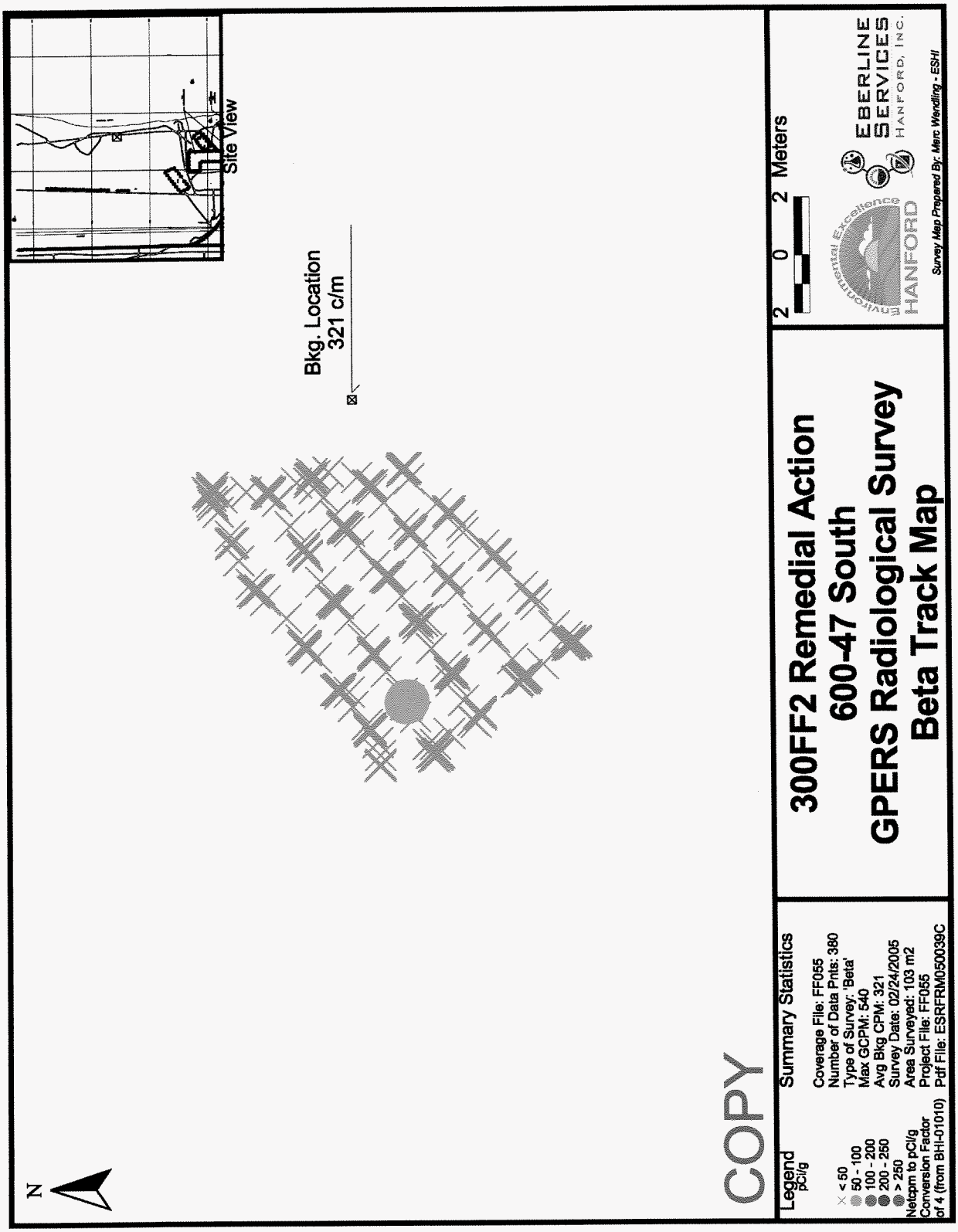


Figure 6. Radiological Mapping Survey Results for the 600-47 Site (Subarea 7).



(BHI 2005). The radiological survey results and the collection and analysis of random verification samples are sufficient to ensure the absence of hot spots for the site COCs.

3.3 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification samples were collected on May 25, 2005. The final verification samples were submitted to offsite laboratories for analysis using approved U.S. Environmental Protection Agency analytical methods as required per the 300 Area SAP (DOE-RL 2004a). Verification samples were composed of a composite of four soil aliquots collected from random locations within decision subunits (excluding the quality assurance/quality control samples).

The sample design methodology and sample location figures are presented in the sample design calculation brief in Appendix C.

The excavated 600-47 site consisted of a single shallow zone decision unit as shown in the sample design figure in Appendix C. The direct exposure, groundwater protection, and river protection RAGs are applicable to soil within this shallow zone decision unit.

4.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 600-47 cleanup verification data for comparison with the data quality criteria and RAGs.

4.1 DATA QUALITY ASSESSMENT PROCESS

A data quality assessment (DQA) is performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 600-47 site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation also verified that the sample design was sufficient to support clean site verification. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

4.2 CONTAMINANTS OF CONCERN 95% UPPER CONFIDENCE LIMIT

The primary statistical calculation to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC are computed for each decision unit (e.g., for the shallow and deep zones, as appropriate). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the 300 Area SAP (DOE-RL 2004a). This process is summarized below.

Verification sampling summary statistics (95% UCL values) are listed in Table 2. Individual sample cleanup verification results are presented in Appendix A.

- **Radionuclides:** The laboratory-reported value is used in the calculation of the 95% UCL. In cases where the laboratory does not report a value for data qualified with a "U" (i.e., less than the detection limit), one-half of the minimum detectable activity is used in the calculation of the 95% UCL.

Table 2. Cleanup Verification Data Set.

COCs	Shallow Zone 95% UCL Statistical Values	Hanford Site Background	Shallow Zone Cleanup Verification Data Set[a]
Radionuclides (pCi/g)[b]			
Uranium (total)	2.79	2.3[c]	0.472
Nonradionuclide Concentration (mg/kg)[b]			
Arsenic	2.2	6.5[d]	2.2 (<BG)
Barium	67	132[d]	67 (<BG)
Beryllium	0.50	1.51[d]	0.50 (<BG)
Cadmium	0.091	0.81[e]	0.091 (<BG)
Chromium	5.3	18.5[d]	5.3 (<BG)
Lead	3.4	10.2[d]	3.4 (<BG)

[a] For overburden, anthropogenic background (DOE-RL 1996) and naturally occurring background is subtracted from all radionuclides. For other decision units (e.g., shallow zone and deep zone), naturally occurring background (uranium) is subtracted. Refer to the 95% UCL calculation brief in Appendix C for additional details on determination of statistical values.
[b] Laboratory data, including the minimum detectable activity or practical quantitation limit for the individual cleanup verification samples, are included in Appendix A and the 95% UCL calculation brief in Appendix C.
[c] Value published in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996).
[d] Value published in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 2001).
[e] Value published in *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).
BG = background
COC = contaminant of concern
UCL = upper confidence limit

- **Nonradionuclides:** For data flagged with a "U" (i.e., less than detection), a value equal to one-half the practical quantitation limit is used in the calculation of the 95%

UCL, as required by Washington State Department of Ecology regulations (*Washington Administrative Code* [WAC] 173-340-740[7][g]).

For nonradionuclides, if greater than half of the sample results for a given COC are below detection, the statistical value is set equal to the maximum concentration detected (i.e., versus computing a 95% UCL).

Statistical calculations are presented in the 600-47 cleanup verification 95% UCL calculation brief (Appendix C). The columns on the left side of Table 2 are the 95% statistical values before subtraction of background, if appropriate. The columns on the right side of the table present statistical values adjusted for background, when background values exist. Typically, Hanford Site background concentration values are subtracted only for uranium.

4.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

A site-specific vadose zone model was not developed for the 600-47 site. The statistical values for total uranium are slightly above background, but are below the applicable cleanup criteria as reported in the ESD (EPA 2004) and the RDR/RAWP (DOE-RL 2004b).

4.4 RESRAD MODELING

A site-specific RESidual RADioactivity (RESRAD) model was not developed for the 600-47 site. The statistical values for total uranium are slightly above background, but are below the applicable cleanup criteria as reported in the ESD (EPA 2004) and the RDR/RAWP (DOE-RL 2004b).

5.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

This section demonstrates that remedial actions at the 600-47 site have achieved the applicable RAGs. Cleanup objectives for the 600-47 site are based on cleanup levels for the 300 Area unrestricted land-use scenario as established in the ESD (EPA 2004).

5.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

5.1.1 Radionuclides

The cleanup verification statistical value for total uranium (2.79 pCi/g) is slightly above the statistical background level (2.3 pCi/g), but meets the direct exposure RAG of

56 pCi/g, the concentration corresponding to a 15 mrem/yr excess dose rate (DOE-RL 2004b). No other radionuclide COCs were identified for the 600-47 site.

5.1.2 Nonradionuclides

5.1.2.1 Direct Comparison to RAGs. Table 3 compares the cleanup verification statistical values presented in Table 2 to the direct exposure RAGs presented in Table 1.

Table 3. Attainment of Nonradionuclide Unrestricted Land Use Direct Exposure Standards.

Nonradionuclides	Direct Exposure RAG (mg/kg)	Statistical Value (mg/kg)	Direct Exposure RAGs Attained?[a]
Shallow Zone			
Arsenic	20[b]	2.2	Yes
Barium	1,600	67	Yes
Beryllium	10.4[c]	0.50	Yes
Cadmium	13.9[c]	0.091	Yes
Chromium	120,000[d]	5.3	Yes
Lead	353	3.4	Yes

[a] Criterion is comparison to direct exposure RAG.
[b] Value derived from WAC 173-340-750 Method A.
[c] Value calculated based on the inhalation exposure pathway per WAC 173-340-750(4)(b)(ii)(A) or (B).
[d] Measured as total chromium.
RAG = remedial action goal
WAC = *Washington Administrative Code*

5.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained. For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specify the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (DOE-RL 2001). Hazard quotients for the nonradionuclide COCs were not calculated because the associated statistical values were less than applicable background values within the shallow zone.

5.1.2.3 Carcinogenic Risk RAG Attained. For individual nonradionuclide carcinogenic COCs, the WAC 173-340-745(4)(a)(iii) Method C cleanup limits are based on an unrestricted land-use incremental cancer risk of 1×10^{-5}. The cumulative excess cancer risk for all nonradionuclide carcinogenic COCs must also be less than 1×10^{-5} (EPA et al. 1998). The only nonradionuclide carcinogenic COCs at the 600-47 site were arsenic, beryllium, and cadmium, which were detected at less than applicable background values. Consequently, excess cancer risk values were not calculated.

5.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

5.2.1 Radionuclides

The cleanup verification statistical value for total uranium (2.79 pCi/g) is slightly higher than the statistical background level (2.3 pCi/g), but is well below the RAG for the protection of groundwater (37 pCi/g), as calculated by RESRAD based on the exposure scenario (DOE-RL 2004b). No other radionuclide COCs were identified for the 600-47 site.

5.2.2 Nonradionuclides

None of the nonradionuclide COCs for the 600-47 site are predicted to reach groundwater within 1,000 years based on a generic site profile for the 300 Area (DOE-RL 2004b). Furthermore, none of these COCs were detected above background levels in the cleanup verification data set, as shown in Table 2.

5.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

5.3.1 Radionuclides

The cleanup verification statistical value for total uranium (2.79 pCi/g) is slightly higher than the statistical background level (2.3 pCi/g), but is well below the RAG for the protection of the Columbia River (74 pCi/g) (DOE-RL 2004b). No other radionuclide COCs were identified for the 600-47 site.

5.3.2 Nonradionuclides

None of the nonradionuclide COCs for the 600-47 site are predicted to reach groundwater, and thus the Columbia River, within 1,000 years based on a generic site profile for the 300 Area (DOE-RL 2004b). Furthermore, none of these COCs were detected above background levels in the cleanup verification data set, as shown in Table 2.

5.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

The WAC 173-340-740(7)(e) three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the cleanup level, (2) no single detection can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10%. The most restrictive RAG (defined as the lowest of the direct exposure, groundwater protection, and river protection RAGs) is used for the test.

All nonradionuclide COCs for the 600-47 site were detected at levels less than applicable background values. Consequently, the WAC 173-340-740(e) three-part test

was not performed.

6.0 STATEMENT OF PROTECTIVENESS

This cleanup verification package demonstrates that remedial action at the 600-47 site has achieved the remedial action objectives and corresponding RAGs established for unrestricted land use in the ROD (EPA 2001), the ESD (EPA 2004), and the RDR/RAWP (DOE-RL 2004b). The contaminated materials from the 600-47 site have been excavated and disposed of at ERDF. The remaining soils at this site have been sampled, analyzed, and modeled. The analytical and modeling results indicate that residual concentrations in the shallow zone will support future land uses that can be represented (or bounded) by an unrestricted land-use scenario and that residual concentrations throughout this site pose no threat to groundwater or the Columbia River. This site has no deep zone. Therefore, no deep zone institutional controls are required. The 600-47 site is verified to be remediated in accordance with the ROD (EPA 2001) and ESD (EPA 2004) and may be backfilled.

7.0 REFERENCES

BHI, 2001, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005, *Closeout Plan for Waste Site 600-47*, CCN 121191, Bechtel Hanford, Inc., Richland, Washington.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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WAC 173-340, 1996, "Model Toxics Control Act – Cleanup," *Washington Administrative Code.*

APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. Shallow Zone Cleanup Verification Data.

Sample Area	HEIS No.	Sample Date	Arsenic			Barium			Beryllium			Cadmium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J036X2	05/25/2005	1.8E+00		3.9E-01	5.56E+01		2E-02	4.2E-01		9E-03	9.0E-02		3E-02
A1 Duplicate of J036X2	J036X6	05/25/2005	2.0E+00		4.1E-01	6.15E+01		2E-02	4.9E-01		9E-03	6.0E-02		3E-02
A1 Split of J036X2	J036X7	05/25/2005	2.0E+00		1.0E+00	8.1E+01		2.1E+01	2.5E-01	J	5.2E-01	5.2E-01	U	5.2E-01
A2	J036X3	05/25/2005	2.3E+00		3.4E-01	6.59E+01		2E-02	4.9E-01		8E-03	9.0E-02		2E-02
A3	J036X4	05/25/2005	1.7E+00		3.4E-01	5.0E+01		2E-02	4.0E-01		8E-03	6.0E-02		2E-02
A4	J036X5	05/25/2005	1.9E+00		4.1E-01	6.7E+01		2E-02	5.0E-01		9E-03	9.0E-02		3E-02

Sample Area	HEIS No.	Sample Date	Chromium			Lead			Uranium (total)		
			mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA
A1	J036X2	05/25/2005	3.9E+00		6E-02	2.4E+00		2.2E-01	1.81E+00		1.9E-01
A1 Duplicate of J036X2	J036X6	05/25/2005	4.8E+00		6E-02	2.7E+00		2.3E-01	1.59E+00		2.0E-01
A1 Split of J036X2	J036X7	05/25/2005	7.4E+00		1.0E+00	2.6E+00		1.0E+00	2.76E+00		5.5E-02
A2	J036X3	05/25/2005	5.0E+00		5E-02	3.3E+00		1.9E-01	1.35E+00		1.7E-01
A3	J036X4	05/25/2005	4.2E+00		5E-02	2.9E+00		1.9E-01	2.60E+00		1.7E-01
A4	J036X5	05/25/2005	5.5E+00		6E-02	3.5E+00		2.3E-01	2.96E+00		1.5E-01

HEIS = Hanford Environmental Information System
J = Estimated result. Result is less than the reporting limit.
MDA = minimum detectable activity
PQL = *practical quantitation limit*
Q = qualifier
U = undetected

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 600-47 SITE

B1.1 OVERVIEW

This data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA involves the scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use (i.e., closeout decisions [EPA 2000]). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures*. Specific data quality objectives for the site are found in the *300 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2004a). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (RDR/RAWP) (DOE-RL 2004b).

Prior to performing statistical tests, the field logbook (BHI 2005), sample design, and sample analytical data are evaluated. A portion of the cleanup verification sample analytical data are validated for compliance requirements (DOE-RL 2004b). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP (DOE-RL 2004a) and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. After data evaluation and validation, the appropriate statistical test is performed on the adjusted raw analytical data (see calculation briefs in Appendix C) to determine statistical values for each contaminant. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A.

B1.2 LABORATORY QUALITY MEASURES

All verification samples are subject to laboratory-specific quality assurance (QA) requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory quality control (QC) checks are performed, as appropriate, for the analytical method at a rate of 1 per sample delivery group (SDG),

or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

- Analytical Accuracy. For most analyses, a known quantity of representative analytes of interest (matrix spike [MS]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

- Analytical Precision. Separate aliquots removed from the same sample container (replicate samples) are analyzed for each analytical batch. The replicate sample results (evaluated as relative percent differences [RPDs]) are used to assess analytical precision.

- QC Reference Samples. A QC reference sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.

Laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Bechtel Hanford, Inc. QA group to ensure that the laboratories are performing within laboratory contract requirements.

B1.3 DATA VALIDATION

After sampling was completed, all of the fixed-base laboratory data from one SDG, H3171, were validated to Level C per BHI-EE-01, Procedure 2.5, "Data Package Validation Process." Level C validation procedures are specified in *Data Validation Procedure for Chemical Analysis* (BHI 2000a) and *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b).

Use of level C validation procedures were included in the review of the following items, as appropriate, for each analytical method:

- Sample holding times
- Method blanks

- MS recovery
- Surrogate recovery
- MS/matrix spike duplicate results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of required (or contractual) detection limits (RDLs).

Data flagged by the validator as estimated (i.e., "J") indicate that the associated concentration is an estimate but that the data may be used for decision-making purposes. Data flagged as below detection limits (i.e., "U") indicate the contaminant was analyzed for but not detected, and the concentration is below the minimum detectable activity (MDA) for radionuclides or the practical quantitation limit (PQL) (i.e., reporting limit) for nonradionuclides. For nonradionuclides, nondetects are reported as the PQL. For radionuclides, nondetects report the actual value obtained from analysis (positive or negative but less than the MDA) except for limited analyses where no value can be calculated. In these cases, the MDA is reported. This situation is applicable for sample results that are below detection limits. All other validated results are considered to be accurate within the standard errors associated with the methods.

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and RDLs pursuant to the SAP (DOE-RL 2004a). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the RDL with the respective MDA or PQL is discussed in Section B1.4.

A summary of deficiencies noted during validation of SDG H3171 follows.

Radionuclides. The validation DQA noted no major deficiencies.

Nonradionuclides. The validation DQA noted no major deficiencies.

In the split-duplicate analysis, beryllium was detected in sample J036X7 at less than the reporting limit and was flagged as an estimate. This has no impact on the data, and therefore the data remain useable for decision-making purposes. All other parameters meet acceptance criteria for SDG H3171.

B1.4 DATA EVALUATION

The following paragraphs include the results of the data evaluation for SDGs H3171 and W04665.

The context for assessing the data includes evaluating the sample data using the statistical methodology of the SAP (DOE-RL 2004a) (included in the calculation brief excerpts in Appendix C) and a comparison of analytical results to the parameters as specified in the SAP. This section summarizes the results of the comparison and presents an evaluation of the affected data.

RDL Comparison. Reported analytical detection levels for nondetected analytes were compared to the RDLs specified in the SAP (DOE-RL 2004a). When detected results are obtained, evaluation of detection limits is not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above SAP RDLs for nondetected analytes.

Radionuclides. The reported MDA was below the RDL for all contaminants of concern (COCs).

Nonradionuclides. No PQLs were above the RDLs for nondetected analytes.

Precision and Accuracy Evaluation. Analytical accuracy and precision were evaluated by examination of the percent recovery and RPD of analytical spikes (MS and/or laboratory control sample) between the main and duplicate samples. Only the COCs detected at five times the detection limit (or greater) are used for data analysis with respect to accuracy and precision.

In SDG H3171, chromium and lead had a high RPD (>20%) in the laboratory duplicate; however, a 20% RPD is acceptable for project criteria. The RPDs for all other laboratory duplicates were within acceptable limits for all COCs.

B1.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples included the following:

- Duplicates and splits:
  - Duplicate J036X6, associated with sample J036X2
  - Split J036X7, associated with sample J036X2.

All main and QA/QC sample results are presented in Appendix A.

B1.5.1 Field Duplicate Samples

Duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the contractual RDLs for both the main and duplicate samples are compared. Based on these criteria, RPD analysis was not required for any duplicate pairs. The 95% upper confidence limit calculation brief in Appendix C provides details on duplicate pair evaluation and RPD calculation.

B1.5.2 Field Split Samples

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the contractual RDL for both the main and split sample were compared. Based on these criteria, RPD analysis was not required for any split pairs. The 95% upper confidence limit calculation brief in Appendix C provides details on split pair evaluation and RPD calculation.

B1.6 SUITABILITY OF DATA

The DQA for the 600-47 site determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. All analytical data were found to be acceptable for decision-making purposes, and the raw data are acceptable for calculating the required statistical values.

B2.0 REFERENCES

BHI, 2000a, *Data Validation Procedure for Chemical Analysis*, BHI-01435, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005, *300-FF-2 Field Sampling Logbook*, EL-1395-10, Bechtel Hanford, Inc., Richland, Washington.

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EPA, 2000, *Guidance for Data Quality Assessment*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

APPENDIX C

CALCULATION BRIEF EXCERPTS

DISCLAIMER FOR CALCULATIONS

The attached calculations have been generated for a specific purpose and task. Use of these calculations by persons who do not have access to all pertinent facts may lead to incorrect conclusions and/or results. Before applying these calculations to your work, the underlying basis, rationale, and other pertinent information relevant to these calculations must be thoroughly reviewed with appropriate ERC officials or other authorized personnel. The Hanford Site ERC is not responsible for the use of a calculation not under its direct control.

CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with BHI-DE-01, *Design Engineering Procedures Manual*, EDPI-4.37-01, "Project Calculations," Bechtel Hanford, Inc., Richland, Washington.

600-47 Dump Sites Shallow Zone Sampling Plan, 0300X-CA-V0055, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

600-47 Cleanup Verification 95% UCL Calculation, 0600X-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

NOTE: The calculation briefs referenced in this appendix are kept in the active Environmental Restoration Contractor project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository. Only excerpts of the calculation briefs are included in this appendix.

CALCULATION COVER SHEET

Project Title:	600-47 Dump Sites Sample Design	**Job No.**	22192
Area	300 Area		
Discipline	Environmental Engineering	**Calc. No.**	0300X-CA-V0055
Subject	600-47 Dump Sites Shallow Zone Sampling Plan		
Computer Program	Excel	**Program No.**	Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These documents should be used in conjuction with other relevent documents in the administrative record.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sht Calc = 1 Shts Attach1 = 1 Sht Attach2 = 1 Sht Attach3 = 1 Shts Total = 5 Shts	G. Cruz 7/14/05	C.A. Bentz 7/14/05	C.A. Lerch 7/18/05	M.J. Haass	7-18-05
SUMMARY OF REVISIONS						

*Obtain Calc. No. from DIS

DE01-437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz Date 7/14/2005 Calc. No. 0300X-CA-V0055 Rev. No. 0

Project 600-47 Dump Sites Sample Design Job No. 22192 Checked CAB Date 7/14/05

Subject 600-47 Dump Sites Shallow Zone Sampling Plan Sheet No. 1of1

Problem: Calculate and display required sampling nodes in concurrence with 300 Area SAP DOE/RL-2001-48 Rev. 0 for verification and closure.

Based on input from the EPA, the sample design was constrained to provide better sample distribution within the excavated sub areas of waste site 600-47. Sample locations were randomly identified within each excavation sub area.

Given:
- -SAP (DOE/RL-2001-48 Rev. 0) requirements
- -Shallow Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 1of1, CAD file 3X:071205A, 600-47 Dump Sites Shallow Zone Sampling Plan)

SAP Requirements:

Shallow Zone:
- -Develop a 16 node sampling grid for the sampling area
- -Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled to collect clean up verification samples

Overburden:
- -Develop a 16 node sampling grid for the sampling area
- -Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled to collect clean up verification samples

Deep Zone:
- -Develop a 16 node sampling grid for the sampling area
- -Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled to collect clean up verification samples

Determination of Shallow Zone Sampling Grid:

Shallow Zone Sampling Grid Area determined from Table 3-2, SAP Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	1393.75	m^2
Area of Decision Subunits (total area 1 subunit)	1393.75	m^2
Decision Subunit divided into 4 Sampling Areas:	VARIES	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	VARIES	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)

See Attachment 3, Sht 1of1, 600-47 Dump Sites Shallow Zone Sampling Plan, for Sample Location Table

Bechtel Hanford, Inc.

Originator G. Cruz Date 7/14/2005 Calc. No. 0300X-CA-V0055 Rev. No. 0

Project 600-47 Dump Sites Sample Design Job No. 22192 Checked CAB Date 7/14/05

Subject 600-47 Dump Sites Shallow Zone Sampling Plan Sheet No 1of1

ATTACHMENT 1

Sample Grid Point Lookup Table.

Default Plan	Sampling Area 1	Sampling Area 2	Sampling Area 3	Sampling Area 4	Sampling Area 5	Sampling Area 6	Sampling Area 7	Sampling Area 8	Sampling Area 9	Sampling Area 10
Closeout	3	6	1	4	5	1	3	3	4	16
Closeout	4	7	11	3	15	15	5	13	10	10
Closeout	16	3	2	7	7	10	11	4	3	14
Closeout	10	15	4	12	1	13	4	8	16	4
Not Sampling	2	14	5	9	13	12	8	2	14	8
Not Sampling	13	10	9	13	2	16	1	12	5	3
Not Sampling	6	1	10	8	14	4	16	5	8	6
Not Sampling	1	9	13	1	10	5	12	1	1	15
Not Sampling	9	12	7	5	6	2	6	7	15	9
Not Sampling	15	16	15	14	16	6	2	15	11	1
Not Sampling	8	13	8	10	12	11	13	14	2	12
Not Sampling	5	2	3	11	4	3	9	10	7	11
Not Sampling	7	11	14	15	11	14	14	6	13	2
Not Sampling	11	4	6	2	9	7	7	11	9	7
Not Sampling	12	8	16	16	3	8	15	9	6	13
Not Sampling	14	5	12	6	8	9	10	16	12	5

** **Note:** Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwesternmost node. Then number consecutively left to right.

Bechtel Hanford, Inc.

Originator G. Cruz Date 7/14/2005 Calc. No. 0300X-CA-V0055 Rev. No. 0

Project 600-47 Dump Sites Sample Design Job No. 22192 Checked CAB Date 7/14/05

Subject 600-47 Dump Sites Shallow Zone Sampling Plan Sheet No. 1of1

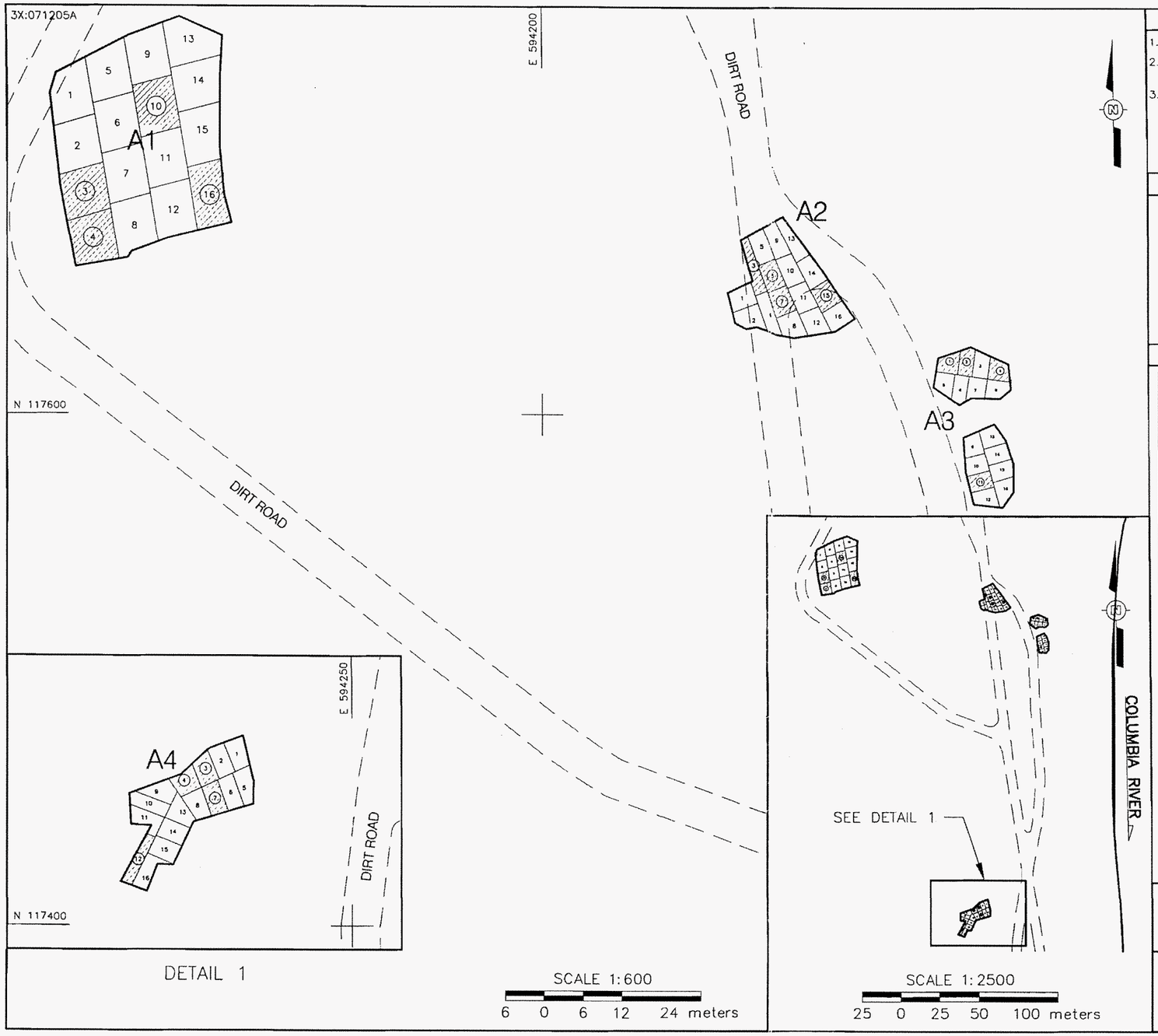
ATTACHMENT 2

Number of Decision Subunits Based on Area.

Site Verification Sampling Frequencies Based on Area.

Decision Unit[a]	Waste Site Size[b]	Decision Subunits	Blocks[c]	Discrete Samples	Composite Samples
Shallow zone – 0 10 15 ft	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32
Deep Zone - >15 ft	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32
Overburen/layback stockpiles	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32
Staging pile areas (residual soil)	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32

[a] The shallow zone, deep zone, overburden stockpile, and staging pile areas each represent single decision units. The total number of decision units will vary because individual waste sites may not have a deep zone, overburden stockpile, and/or staging pile areas.
[b] Area of exposed surface after excavation or area of stockpile base (as applicable)
[c] Decision subunits are divided into four blocks to ensure that random sampling locations are not bunched together in one area



NOTES

1. SHALLOW ZONE NODE AREAS VARIES
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3, & A4 WITHIN DECISION SUBUNIT 1.

LEGEND

(8) CLEAN UP VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-3	117634.07	594129.21
		S-A1-4	117627.12	594130.47
		S-A1-10	117647.07	594140.36
		S-A1-16	117633.64	594148.63
	A2	S-A2-3	117623.17	594232.62
		S-A2-6	117621.63	594235.58
		S-A2-7	117617.66	594237.16
		S-A2-15	117618.68	594244.01
	A3	S-A3-1	117608.53	594263.02
		S-A3-2	117608.45	594265.62
		S-A3-4	117607.09	594270.77
		S-A3-11	117589.88	594267.66
	A4	S-A4-3	117423.83	594227.42
		S-A4-4	117421.99	594224.07
		S-A4-7	117419.32	594228.88
		S-A4-12	117409.99	594216.92

Attachment 3 Sheet No. 1 of 1
Originator G. Cruz Date 7/19/05
Checked By CAB Date 7/14/05
Calc. No. 0300X-CA-V0055 Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

300 AREA
300 AREA REMEDIAL DESIGN
600-47 SITE
SHALLOW ZONE SAMPLING PLAN

CALCULATION COVER SHEET

Project Title:	300 Area Remedial Action	**Job No.**	22192
Area	600		
Discipline	Environmental	***Calc. No.**	0600X-CA-V0050
Subject	600-47 Cleanup Verification 95% UCL Calculation		
Computer Program	Excel	**Program No.**	Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These documents should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 4 Total = 5	Kaa for MJC per email 7/27/05 M. J. Cutlip	T. M. Blakley 7/27/05 T. B. Miley 7-27-05	L. M. Dittmer 7/28/05	J. A. Lerch 7/28/05	7/28/05

SUMMARY OF REVISIONS

* Obtain calc no. from DIS

DE01437.03 (12/09/2004)

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator M. J. Cutlip Kaa for M.J.C per email **Date** 07/27/05
Project 300 Area Remedial Action **Job No.** 22192
Subject 600-47 Cleanup Verification 95% UCL Calculation

Calc. No. 0600X-CA-V0050
Checked T. B. Miley JBM
Checked T. M. Blakley Jmb

Rev. No. 0
Date 7-27-05
Date 7/27/05
Sheet No. 1 of 4

Summary

Purpose:
Calculate the 95% upper confidence limit (UCL) to evaluate compliance with cleanup standards for the 600-47 site. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes, perform the *Washington Administrative Code* (WAC) 173-340 (Model Toxics Control Act [MTCA]) 3-part test, if required, and calculate the relative percent difference (RPD) for each contaminant of concern (COC).

Table of Contents:

Given/References:
1) Sample Results
2) All lookup values and remedial action goals (RAGs) are taken from the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) (DOE-RL 2004b) and Ecology (1996) unless otherwise specified.
3) Background value for cadmium is from *Natural Background Soil Metals Concentration in Washington State*, Publication 94-115, Washington Department of Ecology, Olympia, Washington.
4) Background values for all other analytes are from *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) DOE-RL, 2004a, *300 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-48, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
6) DOE-RL, 2004b, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*, DOE/RL-2001-47, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
7) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington.
8) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below- PQL Values (Censored Data Sets)*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington.
9) Ecology, 1996, *Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARC II)*, Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
10) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.
11) WAC 173-340, 1996, "Model Toxics Control Act--Cleanup," *Washington Administrative Code*.

Solution:
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), and below. Use data from attached worksheets to calculate the 95% UCL for each analyte, the carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and the RPD calculations for each COC.

Calculation Description:
The subject calculations were performed on data from soil verification samples from the subject waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by utilizing the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2004b) is documented by this calculation. Split and duplicate RPD results are used in evaluation of data quality and are presented in the cleanup verification package (CVP) for this site.

Methodology:
The statistical value calculated to evaluate the effectiveness of cleanup was the 95% UCL. For nonradioactive analytes with > 50% of the data below detection limits, the maximum value for the sample data was used instead of the 95% UCL. All nonradionuclide (e.g., metals) data reported as being below detection limits were set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimal detectable activity (MDA), half of the MDA is used in the calculation.

For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n < 10) and all radionuclide data sets, the calculations are performed assuming nonparametric distribution, and no test for distribution is performed. For nonradionuclide data sets of ten or greater, distributional testing is done using Ecology's MTCAStat software (Ecology 1993).

The estimated hazard quotient (for applicable nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 Method B non-carcinogenic cleanup limit. The nonradionuclide carcinogenic risk, above background, is determined by dividing the statistical value by the WAC 173-340 Method B carcinogenic cleanup limit and then multiplying by 10^{-6}. For data sets where all values are below detection, neither of these calculations are required.

The WAC 173-340 3-part test is performed for nonradionuclide analytes only and determines if:
1) the statistical value exceeds the most stringent cleanup limit for each non-radionuclide COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each non-radionuclide COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each non-radionuclide COC.

The RPD is performed when both the main value and either the duplicate or split values are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method. These detection limit requirements are located in Table 2-1 of the sampling and analysis plan (DOE-RL 2004a). The RPD calculations use the following formula: RPD =[|M-S|/((M+S)/2)]*100

where, M = Main Sample Value S = Split (or duplicate) Sample Value

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than +/- 30% indicates the data compare favorably. For regulatory splits, a threshold of +/- 35% is used (EPA 1994). If the RPD is greater than +/- 30% (or +/- 35% for regulatory split data), further investigation regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable CVP.

If regulator split comparison is required, an additional parameter is evaluated. A control limit of +/- 2 times the TDL shall be used if either the main or regulator split value is less than 5 times the TDL and above detection. In the case where only one result is greater than 5 times the TDL and the other is below, the +/- 2 times the TDL criteria applies. Therefore, the following calculation is performed as part of the evaluation for these two cases involving regulator split data: difference = main - regulator split.

If the difference is greater than +/- 2 times the TDL, then further investigation regarding the usability of the data is performed and presented in the applicable CVP data quality assessment section.

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator M. J. Cutlip plan for MJC per email Date 07/27/05
Project 300 Area Remedial Action Job No. 22192
Subject 600-47 Cleanup Verification 95% UCL Calculation

Calc. No. 0600X-CA-V0050
Checked T. B. Miley TBM
Checked T. M. Blakley TMB

Rev. No. 0
Date 7-27-05
Date 7/27/05
Sheet No. 2 of 4

Summary (continued)

Results:
The results presented in the summary tables that follow are for use in RESRAD dose/risk analysis and the CVP for this site.

Result Summary - Shallow Zone

Analyte	Result	Qualifier	Units
As	2.2E+00		mg/kg
Ba	6.7E+01		mg/kg
Be	5.0E-01		mg/kg
Cd	9.1E-02		mg/kg
Cr	5.3E+00		mg/kg
Pb	3.4E+00		mg/kg
U (Total)	4.72E-01		pCi/g

WAC 173-340 Evaluation (Shallow Zone)

WAC 173-340 3-Part Test:
Because all values are below background, the 3-part test and excess risk are not calculated.

Relative Percent Difference (RPD) Results (Shallow Zone)* QA/QC Analysis

Analyte	Duplicate Analysis	Split Analysis
As		
Ba		
Be		
Cd		
Cr		
Pb		
U (Total)		

*A blank cell indicates that RPD evaluation was not required.
CVP = cleanup verification package
QA/QC = quality assurance/quality control
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Shallow Zone Area Sample Data

Sampling Area	HEIS Number	Sample Date	As mg/kg	As Q	As PQL	Ba mg/kg	Ba Q	Ba PQL	Be mg/kg	Be Q	Be PQL	Cd mg/kg	Cd Q	Cd PQL	Cr mg/kg	Cr Q	Cr PQL	Pb mg/kg	Pb Q	Pb PQL	U (Total) pCi/g	U (Total) Q	U (Total) MDA
A-1	J036X2	5/25/2005	1.8E+00		3.9E-01	5.56E+01		2E-02	4.2E-01		9E-03	9.0E-02		3E-02	3.9E+00		6E-02	2.4E+00		2.2E-01	1.81E+00		1.9E-01
Duplicate of J036X2	J036X6	5/25/2005	2.0E+00		4.1E-01	6.15E+01		2E-02	4.9E-01		9E-03	6.0E-02		3E-02	4.8E+00		6E-02	2.7E+00		2.3E-01	1.59E+00		2.0E-01
A-2	J036X3	5/25/2005	2.3E+00		3.4E-01	6.59E+01		2E-02	4.9E-01		8E-03	9.0E-02		2E-02	5.0E+00		5E-02	3.3E+00		1.9E-01	1.35E+00		1.7E-01
A-3	J036X4	5/25/2005	1.7E+00		3.4E-01	5.0E+01		2E-02	4.0E-01		8E-03	6.0E-02		2E-02	4.2E+00		5E-02	2.9E+00		1.9E-01	2.60E+00		1.7E-01
A-4	J036X5	5/25/2005	1.9E+00		4.1E-01	6.7E+01		2E-02	5.0E-01		9E-03	9.0E-02		3E-02	5.5E+00		6E-02	3.5E+00		2.3E-01	2.96E+00		1.5E-01

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	As mg/kg	Ba mg/kg	Be mg/kg	Cd mg/kg	Cr mg/kg	Pb mg/kg	U (Total) pCi/g
A-1	J036X2/ J036X6	5/25/2005	1.9E+00	5.9E+01	4.6E-01	7.5E-02	4.4E+00	2.6E+00	1.70E+00
A-2	J036X3	5/25/2005	2.3E+00	6.6E+01	4.9E-01	9.0E-02	5.0E+00	3.3E+00	1.35E+00
A-3	J036X4	5/25/2005	1.7E+00	5.0E+01	4.0E-01	6.0E-02	4.2E+00	2.9E+00	2.60E+00
A-4	J036X5	5/25/2005	1.9E+00	6.7E+01	5.0E-01	9.0E-02	5.5E+00	3.5E+00	2.96E+00

Statistical Computations

	As	Ba	Be	Cd	Cr	Pb	U (Total)
Statistical value based on	Small data set. Use nonparametric z-stat.	Small data set. Use nonparametric z-stat.	Small data set. Use nonparametric z-stat.	Small data set. Use nonparametric z-stat.	Small data set. Use nonparametric z-stat.	Small data set. Use nonparametric z-stat.	Radionuclide data set. Use nonparametric z-stat
N	4	4	4	4	4	4	4
% < Detection limit	0%	0%	0%	0%	0%	0%	0%
mean	2.0E+00	6.0E+01	4.6E-01	7.9E-02	4.8E+00	3.1E+00	2.15E+00
st. dev.	2.5E-01	7.9E+00	4.5E-02	1.4E-02	6.0E-01	4.2E-01	7.53E-01
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645	1.645
95% UCL on mean	2.2E+00	6.7E+01	5.0E-01	9.1E-02	5.3E+00	3.4E+00	2.77E+00
max value	2.3E+00	6.7E+01	5.0E-01	9.0E-02	5.5E+00	3.5E+00	2.96E+00
Statistical value	2.2E+00	6.7E+01	5.0E-01	9.1E-02	5.3E+00	3.4E+00	2.77E+00
Background	NA	NA	NA	NA	NA	NA	2.3
Statistical value above background	2.2E+00	6.7E+01	5.0E-01	9.1E-02	5.3E+00	3.4E+00	4.72E-01
Most Stringent Unrestricted Use Cleanup Limit for nonradionuclide and RAG type	20 a Direct Exposure	1,600 a Direct Exposure	10.4 a Direct Exposure	13.9 a Direct Exposure	120,000 a Direct Exposure	353 a Direct Exposure	
WAC 173-340 Compliance? NA	Because all As values are below the background of 6.5 mg/kg, the 3-part test and excess risk are not calculated.	Because all Ba values are below the background of 132 mg/kg, the 3-part test and excess risk are not calculated.	Because all Be values are below the background of 1.51 mg/kg, the 3-part test and excess risk are not calculated.	Because all Cd values are below the background of 0.81 mg/kg, the 3-part test and excess risk are not calculated.	Because all Cr values are below the background of 18.5 mg/kg, the 3-part test and excess risk are not calculated.	Because all Pb values are below the background of 10.2 mg/kg, the 3-part test and excess risk are not calculated.	
Nonrad noncarcinogenic index sum: NA							
Nonrad carcinogenic risk: NA							

a = Based on the generic site RESRAD assessment included in the RDR/RAWP (DOE-RL 2004b), as well as numerous site-specific assessments, these contaminants will not migrate to groundwater or the river and are, therefore, not a threat to groundwater or the river. For the shallow zone, the direct exposure criteria is the most stringent cleanup criteria for these contaminants.

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
WAC = *Washington Administrative Code*

Originator M. J. Cutlip *(Calc for MJC per email*
Project 300 Area Remedial Action
Subject 600-47 Cleanup Verification 95% UCL Calculation

Date: 07/27/05
Job No.: 22192

Calc. No.: 0600X-CA-V0050
Checked: T. B. Miley JBM
Checked: T. M. Blakley TMB

Rev. No.: 0
Date: 7-27-05
Date: 7/27/05
Sheet No.: 4 of 4

Split-Duplicate Analysis:

Shallow Zone

Composite Area	HEIS Number	As			Ba			Be			Cd			Cr			Pb			U (Total)		
		mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA
A-1	J036X2	1.8E+00		3.9E-01	5.6E+01		2.0E-02	4.2E-01		9.0E-03	9.0E-02		3.0E-02	3.9E+00		6.0E-02	2.4E+00		2.2E-01	1.81E+00		1.90E-01
Duplicate of J036X2	J036X6	2.0E+00		4.1E-01	6.15E+01		2.0E-02	4.9E-01		9.0E-03	6.0E-02		3.0E-02	4.8E+00		6.0E-02	2.7E+00		2.3E-01	1.59E+00		2.00E-01
Split of J036X2	J036X7	2.0E+00		1.0E+00	8.1E+01		2.1E+01	2.5E-01	J	5.2E-01	5.2E-01	U	5.2E-01	7.4E+00		1.0E+00	2.6E+00		1.0E+00	2.76E+00		5.5E-02

Shallow Zone Analysis:

TDL		10	20	0.5	0.5	1	10	1
Duplicate Analysis	Both >MDA?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD							
Split Analysis	Both >MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)			No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD							

HEIS = Hanford Environmental Information System
J = Estimated result. Result is less than the reporting limit.
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
RPD = relative percent difference
TDL = target detection limit
U = undetected

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